Norsewind - array of wind lidars and meteorological masts offshore

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Publication date:
2013

PO.ID 241

NORSEWIND – ARRAY OF WIND LIDARS AND METEOROLOGICAL MASTS OFFSHORE

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Introduction

The FP7 project Norsewind (2008-2012) focused on the offshore study of winds through observations with ground-based wind lidars, meteorological masts and satellite remote sensors, and mesoscale modeling. Some results of the observational array of wind lidars and meteorological masts are presented.

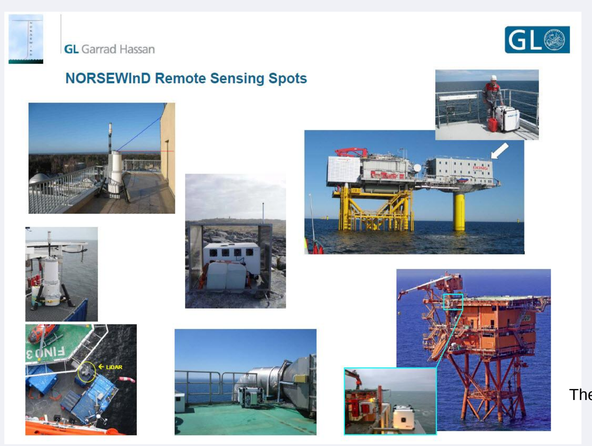
Approach

The approach of the measurement campaign in Norsewind was to cover the Baltic, North and Irish Seas with an array of wind lidars installed on offshore platforms and combine them with existing observations from tall offshore meteorological masts. This resulted in a database with 11 wind lidars and data from around the same number of offshore masts. The work on CFD flow modeling and tunnel experiments on the influence of each of the platforms on the wind lidar observations showed that the measurements are not highly distorted.

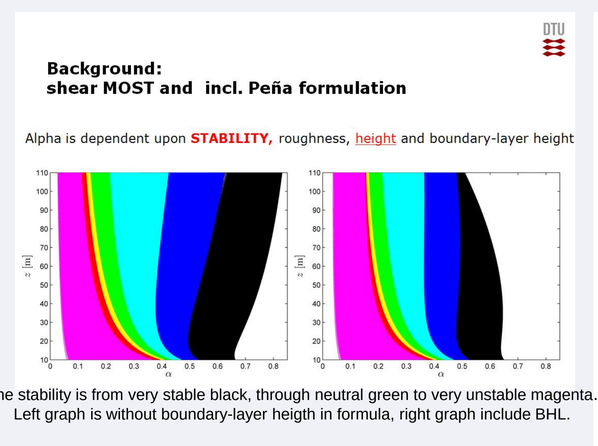
High-quality observations of offshore winds at relevant wind turbine heights are challenging to obtain due to logistics and cost. In the Norsewind project an array of wind lidars and meteorological masts were used to assess winds at local points. The major findings from the meteorological observations from masts and wind lidars can be summarized as new knowledge on the vertical wind shear profile offshore. It is generally known that winds in near neutral conditions in the surface boundary layer can be described with the logarithmic profile. The new observations confirmed that this situation is not that frequent and the winds at hub-height (e.g. 100 m) are not always truly within the lowest 10% of the boundary layer where the log profile is valid.

The boundary layer height was not observed in the Norsewind project but obtained from model results from the WRF mesoscale model. Only at some meteorological masts were observations of vertical temperature profiles accessible and that allowed detailed physical investigation of the shear during various conditions. From all wind lidar nodes the shear exponent (alpha) was calculated seasonally, daily and for 12 wind directional bins. Finally, the frequency distribution of alpha for each node was calculated. The relationship between alpha and atmospheric stability, roughness, height and boundary layer height was identified from the dataset.

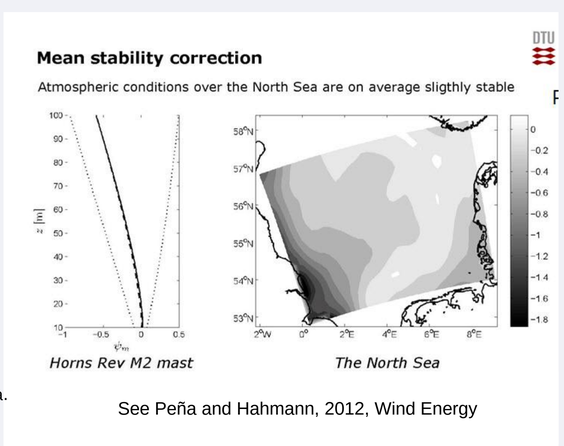
Map of Northern European Seas and installed instruments.



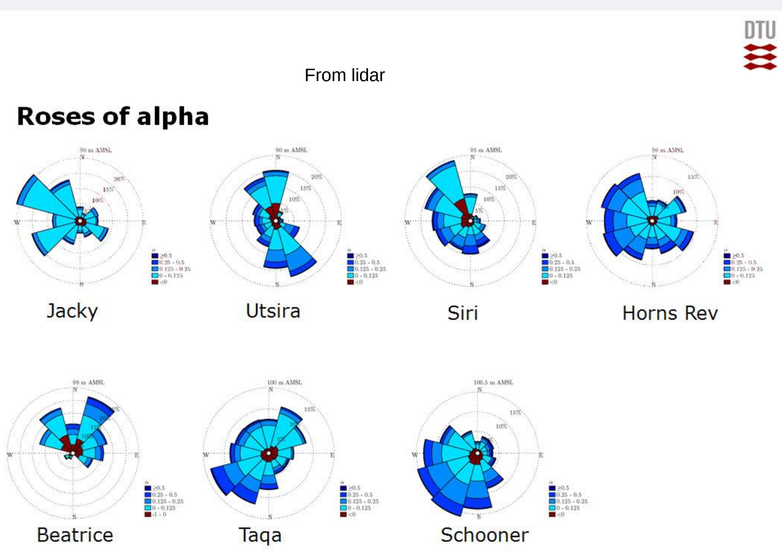
Graphs of alpha: theory, map of stability and observed alpha roses and pdf's.

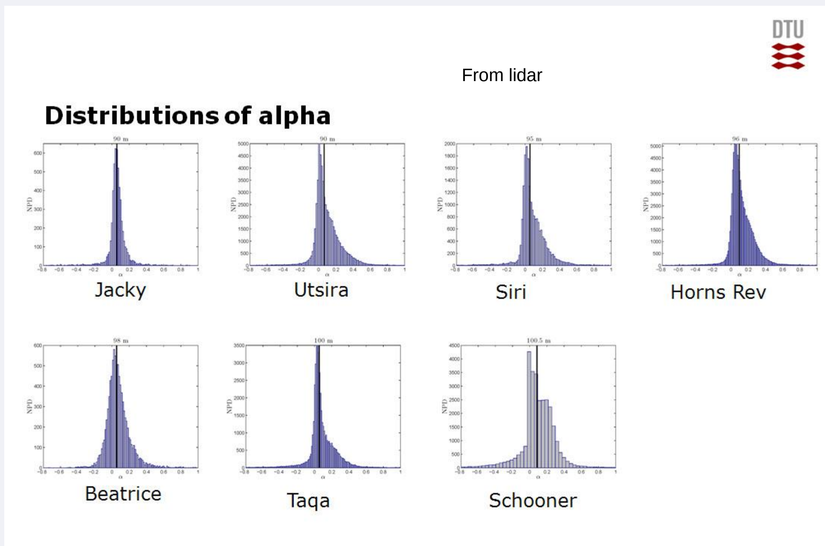


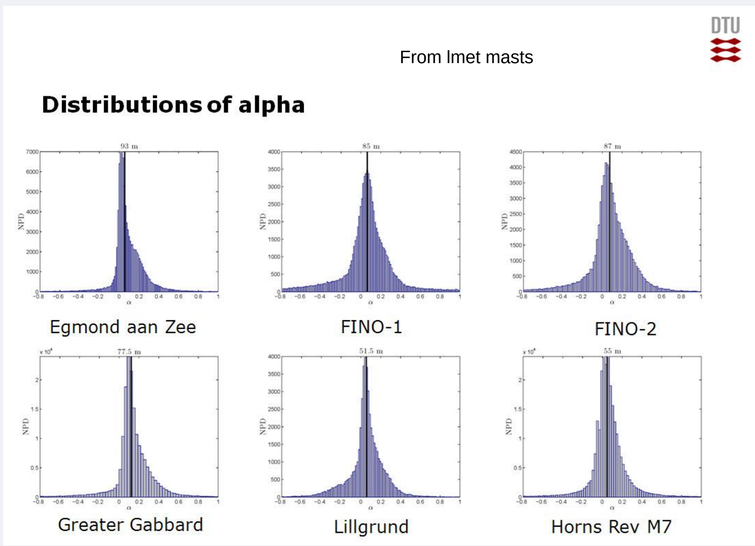
The stability is from very stable black, through neutral green to very unstable magenta. Left graph is without boundary-layer heigth in formula, right graph include BHL.



See Peña and Hahmann, 2012, Wind Energy







Conclusions

The vertical wind shear distribution and 'alpha-roses' observed from the array of wind lidars and meteorological masts in the Norsewind project in the Baltic and North Seas are presented.
The commonly adopted offshore vertical wind shear value, alpha 0.2, is valid for a very narrow set of atmospheric and marine conditions. Alpha varies in the marine SBL with atmospheric stability, roughness (as the sea roughness is not constant and increases with wind speed) and height. In offshore conditions the observed alpha values at 100 m AMSL are often within the range -0.2 to 0.8 with a peak within the range 0 to 0.125. Negative values are found both under unstable and stable atmospheric conditions.

References

Peña, A., T. Mikkelsen, S. E. Gryning, C. B. Hasager, A. Hahmann, M. Badger, I. Karagali and M. Courtney, Offshore vertical wind shear, DTU Wind Energy-E-0005(EN), 2012.
Peña and Hahmann 2012 Atmospheric statbility and turbulence fluxes at Horns Rev – an intercomparison of sonic, bulk and WRF model data, Wind Energy, 15: 717-731
Further information is available at www.norsewind.eu